



# Smart and Autonomous Systems (S&AS) NSF 16-608

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National Science Foundation

Webinar  
November 3, 2016



# The S&AS Team

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- David Corman, CISE/CNS
- Jack Snoeyink, CISE/CCF
- Jie Yang, CISE/IIS
- Seta Bogosyan, OD/OISE
- Daniel Hicks, AAAS Fellow, IIS



# Welcome

- **Erwin Gianchandani** – Deputy Assistant Director  
Computer and Information Science and Engineering



# Outline

- Overview of S&AS Program
- FY 2017 Solicitation
- Program Scope
- Submitting Proposals
- Questions



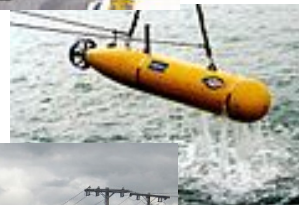
# Autonomy: Definitions

- Independence in one's thoughts or actions, especially moral independence
- Autonomous systems can make choices free of outside influence
- *Autonomy* refers to the ability of a system to operate and adapt to changing circumstances with reduced or without human control
  - From: “Preparing for the Future of Artificial Intelligence”



# Need

- Increasing interest and need for autonomous systems
  - Robots, vehicles, sensor networks, smart infrastructure, ...
  - Manufacturing, health-care, service, exploration, monitoring, sustainability,...
- Need to **minimize human intervention**
  - Systems should self-monitor and report problems
  - Note: **intervention** distinguished from *interaction*
- Need for **adaptation**
  - Deal with new problems and opportunities
  - Deal with changes to system hardware and environment, over time
- Need to consider and maintain **social good**
  - Ethical behavior in the face of conflicting mission and societal goals



# Need

- Recent reports highlight the need for autonomy and ethical behavior in intelligent systems
  - NSF Workshop on Future Directions in Cyber-Physical Systems, Robotics, and Autonomy
    - <http://dl.acm.org/citation.cfm?id=2904482>
  - OSTP reports: “Preparing for the Future of Artificial Intelligence” and “National AI R&D Strategic Plan”
    - <https://www.whitehouse.gov/blog/2016/10/12/administrations-report-future-artificial-intelligence>
  - One Hundred Year Study on Artificial Intelligence
    - <https://ai100.stanford.edu/>



# Goal

- Promote fundamental research into **Intelligent Physical Systems (IPS)**
    - Focus on *autonomy*
  - **IPS**: Integrated hardware and software systems that interact with physical environments and exhibit **five** identifying characteristics
    - **Cognizant**
    - **Taskable**
    - **Reflective**
    - **Ethical**
    - **Knowledge-Rich**
- These characteristics are the *research themes* of S&AS



# Cognizant

- IPS that are aware of their capabilities and limitations
  - Capable of operating autonomously over extended periods of time, with minimal or no human supervision
  - Acting in a manner that is understandable by human collaborators
    - Includes explaining themselves and asking for help, when needed
- Example:
  - A fully autonomous vehicle that knows when the conditions of the environment, or the vehicle itself, are incompatible with self-driving



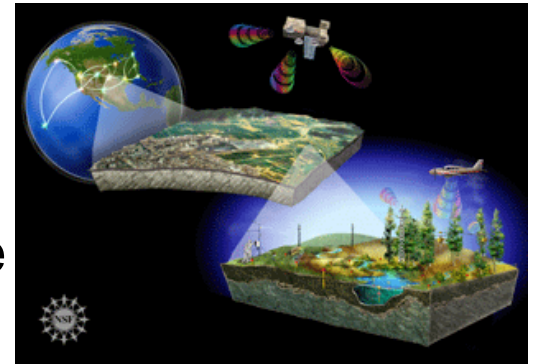
# Taskable

- IPS that handle high-level, often vague, instructions
  - Translate directives into suitable plans for sensing, reasoning, communicating, and acting
  - Accept instructions through various modalities
    - Includes natural language dialog, gesture, sketches, multi-modal, ...
  - Take initiative to achieve necessary or important tasks
  - Capable of performing multiple tasks concurrently
- Example:
  - An underwater glider is tasked with mapping the routes of fish, surfacing every few days



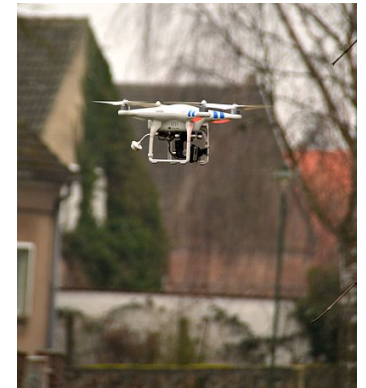
# Reflective

- IPS that learn from experience to improve performance
  - Capable of monitoring their actions, diagnosing problems, and optimizing, reconfiguring, and repairing autonomously
  - Learn and adapt to improve their behavior over time
    - Includes acquiring, modifying, and transforming skills
    - May learn from humans, other IPS, or interactions with the environment
- Example:
  - A network of sensors with reconfigurable sensory platforms that can improve its capabilities over time based on the deployed environment



# Ethical

- IPS that adhere to an ethical system of societal and legal norms
  - Capable of incorporating societal values into their reasoning
  - Recognize moral imperatives, and avoid commands and actions that violate those dictates
  - Correctly apply ethical decision making when multiple goals are in conflict
- Example:
  - An aerial vehicle is tracking a fugitive in a neighborhood; the vehicle must trade off the privacy concerns of citizens with its mission



# Knowledge-Rich

- IPS that reason over a diverse body of knowledge
  - Capable of quantitative and qualitative reasoning, using high-level semantics
  - Reason using multiple models
    - Includes symbolic, ontological, probabilistic, mixed, and commonsense reasoning models
  - Capable of introspectively reasoning about their own reasoning capabilities and limitations
- Example:
  - A smart grid that reasons about sensory load (numeric quantities), types of sensors (semantic knowledge), and anticipated events (commonsense reasoning)



# Project Classes

- **Foundational:**

- Research fundamental techniques, theories, and technologies that contribute to the development of IPS
- Must focus on at least one of the five research themes
- Not required to use a physical testbed, but must include evaluation plan

- **Integrative:**

- Research into novel integration of two, or more, of the five research themes
- Required to evaluate on a physical testbed
- Multiple PIs, from different disciplines, are encouraged



# Award Information

- Anticipated Funding of \$16.5M in FY 2017
- Foundational Projects
  - \$350K–\$700K **total costs**; up to three years
  - Expected to award 15–25 projects
- Integrative Projects
  - \$500K–\$1.4M **total costs**; up to four years
  - Expected to award 10–15 projects

***Note that budget ranges overlap – do not choose project class based on budget requirements***



# What Proposals are Good Fits for S&AS

- The focus of this solicitation is on how **planning, reasoning, self-awareness, and learning** can lead to **autonomous systems that require minimal human intervention** and are **adaptive to changes in environment, mission, and own capabilities**
- Proposals must:
  - Address at least one of the five research themes
  - Include evaluation showing relevance to IPS
  - May include other themes

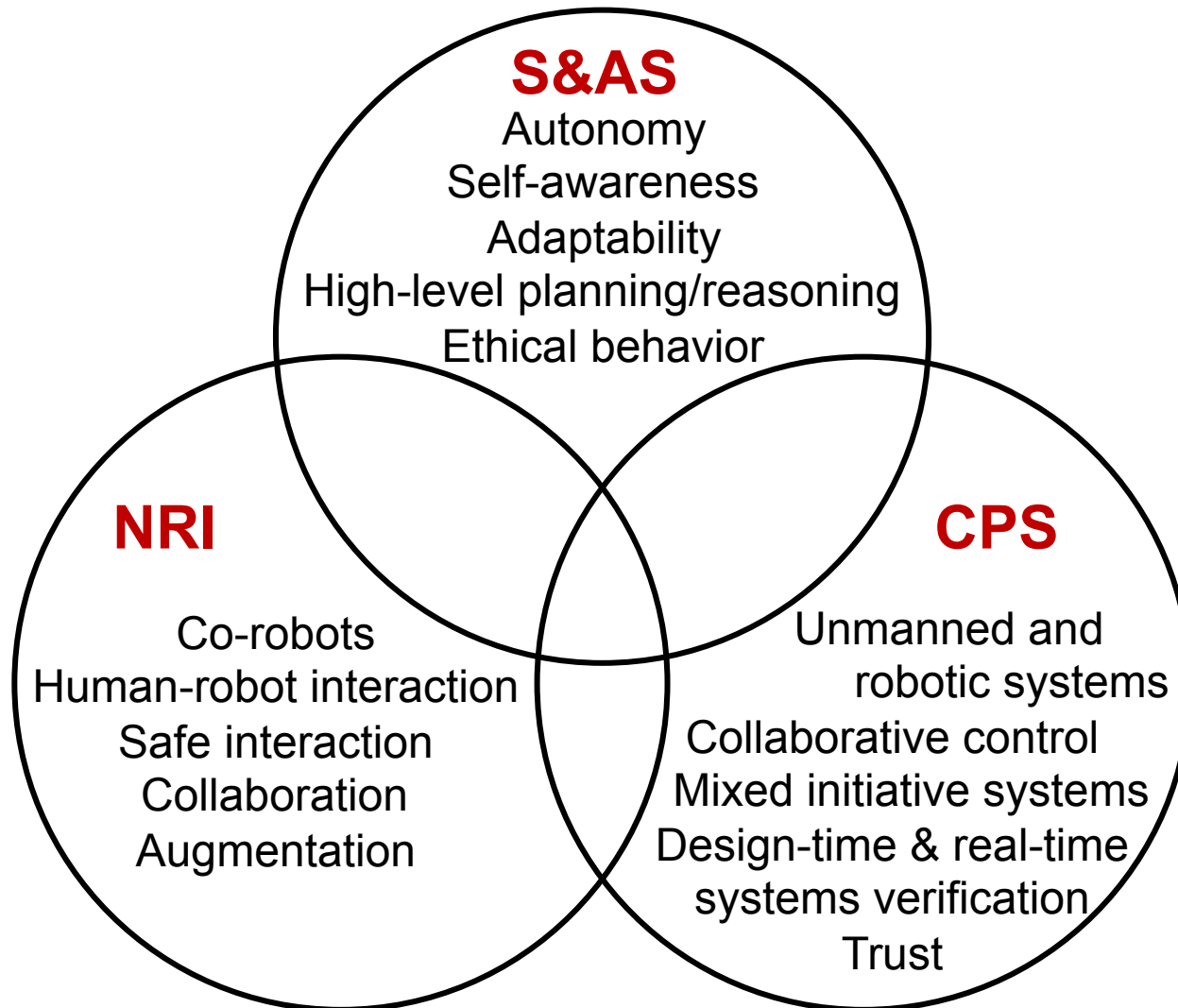


# What Proposals are **Not** Good Fits for S&AS

- Proposals that focus primarily on
  - Purely software (non-embodied) agents
  - Hardware design and development
  - Low-level control
  - Formal verification and validation
  - Security



# Relationships to Other Programs



# Eligibility Requirements

- Universities and Colleges
  - Including community colleges
  - Accredited, and having a campus located, in the US
- Non-profit, non-academic organization
  - Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities
- At most two (2) S&AS proposals for any PI, co-PI, or Senior Personnel in a given year



# Proposal Submission

- Proposal deadline: December 19, 2016  
(due 5pm local time)
  - Refer to the solicitation
    - <http://www.nsf.gov/pubs/2016/nsf16608/nsf16608.htm>
  - Refer to “Proposal and Award Policies Procedures Guide”
    - <https://www.nsf.gov/pubs/policydocs/pappguide/nsf16001>
- Yearly PI meeting in Washington, DC
  - Account for travel in budget



# Supplementary & Single Copy Documents

- Data Management Plan
- List of Project Personnel and Partner Institutions
  - List PIs, co-PIs, senior personnel, consultants, collaborators, subawardees, postdocs, advisory committee members
  - **Lead PI submits**
- Collaboration Plan
  - Any project with **more than one** (1) PI
  - Length commensurate with complexity of project
- Postdoctoral Mentoring Plan (if applicable)
- Collaborators and Other Affiliations (COA)
  - Single copy document for **each** PI, co-PI, senior personnel
  - **Use Excel template at <https://www.nsf.gov/cise/collab>**



# Review Criteria

- ***For All Projects:*** Intellectual Merit
- ***For All Projects:*** Broader Impact
- ***For All Projects:*** Program Relevance
  - Explicitly address the goal of achieving Intelligent Physical Systems that exhibit a high degree of autonomy
- ***For Integrative Projects:***
  - **Innovation** in the integration of the system
  - **Evaluation** plan, including testbed(s), proposed experiments, and evaluation metrics



# Thanks!

- To ask a question, please follow the operator's directions.
- Please send questions via email: [S&AS@nsf.gov](mailto:S&AS@nsf.gov)
- Presentation and FAQ will soon be made available on program website:  
[https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505325](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505325)

